Our Reference: ENL-344-A PATENT

SUBSTITUTE SPECIFICATION

WATER CRAFT

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a water craft having a keel, in particular, but not exclusively, the invention relates to an amphibious vehicle having a keel.

[0002] A keel is provided on the underside of a water craft, for example a boat, amphibious vehicle, surfboard, sailboard or the like, one purpose of which being to assist in the stability and control of the craft in use, in particular against lateral wind and water forces.

[0003] In the case of a small water craft which is intended to be portable and to be stored on land, for example a surfboard or sailboard, a keel can make the craft less portable, and difficult to store.

[0004] An amphibious vehicle is required to emulate a boat as closely as possible on water, as well as operating as a road vehicle on land. A keel is often provided on the hull of an amphibious vehicle to aid handling and manoeuvrability of the vehicle on water. However, in the transition from water to land, or simply as the vehicle manoeuvres on land, there is a risk that the keel may strike or drag on the surface along which the vehicle is moving and thus become damaged. The keel is often mounted on the lowermost part of the hull, and therefore significantly reduces ground clearance.

SUMMARY OF THE INVENTION

[0005] It is an object of the invention to provide a water craft having a keel in which the above mentioned disadvantages are reduced or substantially obviated.

[0006] It is a particular objective of the invention to provide an amphibious vehicle having a keel which has minimal effect on ground clearance when the vehicle is out of the water, but which is readily adaptable to provide useful hydro-dynamic effects when the vehicle is in water.

[0007] Thus, in accordance with the present invention, there is provided a water craft having a longitudinal, elongate keel mounted to the underside of the craft,

the keel comprising at least two elongate keel members, each keel member being movable from a first position in which it projects away from the underside of the craft by a first angle, to a second position in which it projects away from the underside of the craft by a second angle larger than the first, and means for biassing the keel members towards the first position, the arrangement being such that in use, when the keel is subjected to a hydro-dynamic loading, at least one of the keel members is moved towards the second position so as to act as a dependent keel. Preferably, the at least one of the keel members is moved toward the second position when the keel is subjected to a generally lateral hydro-dynamic loading.

[0008] Preferably, the keel members are provided in pairs, with the keel members in each pair projecting from the underside of the water craft in generally laterally opposing directions when the keel portions are in the first position

[0009] Preferably, the keel members are pivotably mounted to a base which is adapted to be mounted to the underside of a water craft. In a particularly preferred embodiment, the keel members are formed integrally with the base, in which case, the keel members and the base may be extruded.

[0010] The keel members may be mounted separately to the underside of the water craft.

[0011] Alternatively, the keel members can be provided in pairs, with the members in each pair pivotably mounted to a common base.

[0012] Preferably, the keel members and their respective bases are extruded.

[0013] The keel members may be made from a resilient material, in which case, it may be the resilience of the material that biases the keel members to the first position.

[0014] The at least two keel members may be provided in pairs, with the keel members in each pair being pivotably connected to a base by means of a common hinge portion. An elongate hollow cavity may be formed in the common hinge portion. In a particular embodiment, the cavity is sealed to prevent water from entering the cavity, the arrangement being such that when hydro-dynamic pressure acting on the common hinge portion compresses the cavity, the keel members are moved toward the second position.

[0015] Preferably, each keel member has a first convex surface and a second concave surface and when the keel members are in the first position, the first surface is directed away from the from the underside of the water craft and the second surface is directed towards the underside of the water craft.

[0016] Preferably, each keel member is movable to a third position in which it projects from the underside of the water craft by a third angle which is smaller than the first angle.

[0017] Preferably, stop means are provided to prevent or resist movement of the keel members beyond the second position.

[0018] Advantageously, the second angle is in a range from 80 to 100 degrees.

[0019] Preferably, the water craft is an amphibious vehicle.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] An embodiment of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

[0021] Figure 1 is a diagrammatic plan view from below of a water craft having a keel in accordance with the invention;

[0022] Figure 2 is a diagrammatic side view of the keel shown in Figure 1;

[0023] Figure 3 is a cross-sectional view taken on line A-A, through a part of the base of the hull of Figure 1 showing part of the keel;

[0024] Figure 4 is a diagrammatic cross-sectional view similar to that of Figure 3, showing the keel in its unloaded condition;

[0025] Figure 5 is a view similar to that of Figure 4, showing the keel in a compressed condition due to contact with the ground or other surface underneath the water craft;

[0026] Figure 6 is a view similar to that of Figure 4 but showing the keel in a hydro-dynamically loaded condition;

[0027] Figure 7 is a view similar to that of Figure 4, showing a further embodiment of the keel in its unloaded condition; and

[0028] Figure 8 is a view similar to that of Figure 3, showing a further embodiment of the invention in which two keel members are separately mounted to the hull, one on either side of the longitudinal centre line.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0029] A water craft in the form of an amphibious vehicle is indicated generally at 10 in Figure 1, having a body which incorporates a hull 12. A keel 14 is provided centrally on the base of the hull 12 in the longitudinal axis and extends along substantially the entire length of the base.

[0030] As can be seen best from Figure 2, the keel 14 comprises a main elongate member 16, which extends along the greater part of the length of the base of the hull 12. The keel also has a tapered tip member 18 which is positioned adjacent to the forward end of the elongate member 16. The tip member 18 may be made of any suitable material but is preferably made from rubber or synthetic rubber and is shaped to provide good hydrodynamic performance as the vehicle travels forwardly through the water. A metal cap 20 may be positioned over the tip member 18 to protect the tip member from damage. The metal cap 20 is shaped to complement the shape of the tip member.

[0031] The construction of the elongate member 16 of the keel 14 can be seen most clearly in Figures 3 and 4. The elongate member 16 is formed as an extrusion of a relatively flexible and resilient material. Any suitable material can be used but in the preferred embodiment the elongate member is made of extruded rubber or synthetic rubber. The elongate member comprises a base 22 and two keel members 24, 26 pivotably attached to the base. In the preferred embodiment, the keel members 24, 26 are formed integrally with the base 22. However, this is not essential and the keel members could be separate members pivotably attached to the base by any suitable means.

[0032] The base 22 is slidably received in a re-entrant channel 28 in an elongate mounting member 30. In a preferred embodiment, the mounting member 30 is manufactured from aluminium or an aluminium alloy by means of extrusion. However, it should be understood that the mounting member can be manufactured from any suitable material, such as plastics or composites, and by any suitable process. The mounting member 30 is located in a channel formation 32 in the hull 12 of the amphibious vehicle or other water craft. The free ends of the base 22 are received between a base wall 34 and flanges 36 of the mounting member 30, for

slidably securing the elongate member 16 to the mounting member 30 and hence to the hull.

[0033] In a preferred embodiment, the re-entrant channel 28 is closed at the rearward end but is open at the forward end of the vehicle. In order to assemble the elongate member to the hull, the base 22 is inserted into the re-entrant channel 28 through the open forward end. Once the elongate member is fully inserted into the mounting member 30, the tip member 18 is affixed to the hull adjacent to the forward end of the mounting member 30, to close off the re-entrant channel 28 and so prevent the elongate member from being withdrawn from the mounting member in use. The metal cap 20 can then be positioned over the tip member. If it is desired to remove the keel, the metal cap 20 and the tip member are first removed from the hull. The elongate member 16 can then be slid out of engagement with the mounting member through the now open forward end of the re-entrant channel 28.

[0034] The above described method of removably mounting the elongate member 16 to the hull is the subject of the applicant's co-pending International patent application which claims priority from British patent application No. GB0226443.0, to which the reader should refer for further details.

[0035] Whilst it is preferred that the elongate member 16 be removably mounted to the hull or underside of a water craft as described above, this is not essential to the present invention and the elongate member can be mounted using any suitable arrangement. For example the elongate member 16 can be secured to the hull using a suitable adhesive or may be secured using any suitable fixing means such as rivets, screws or bolts etc. Thus Figure 4, and Figures 5 to 7 which will be described in more detail below, show the base 22 of the elongate member mounted directly within a recess formed in the hull 12 without the use of a mounting member 30.

[0036] Each keel member 24, 26 is elongate and is mounted to the base 22 along one edge by means of a live hinge 38, located at a position close to the centre line of the base. Figures 3 and 4 show the keel members in an unloaded condition in which they extend laterally outwardly in generally opposing directions from their respective hinges. Each of the keel members has a first surface 42 and a second surface 44. The first surfaces 42 are generally convex and face away from the hull

when the keel is unloaded. The second surfaces are generally concave and face towards the hull when the keel is unloaded. Each of the keel members also has a stop 46 projecting from their respective second surfaces 44 for contact with a corresponding protuberance or stop 48 formed on a lower surface of the base, for reasons which will be described below.

[0037] Referring also to Figures 5 to 6, operation of the keel 14 will now be described.

[0038] As described above, the elongate member 16 is made of a resilient material, preferably rubber or synthetic rubber. Due to the resilience of the material and the design of the hinges 38, the keel members 24, 26 tend to adopt a first position in which they are aligned close to, though slightly spaced from, the base 22 when they are in a relaxed or unloaded condition, as shown in Figure 3 and in shaded outline in Figure 4. However, as can be seen from Figures 3 and 4, whilst the keel members 24, 26 are aligned close to the base 22 in the first position, they are arranged at a slight angle such that the free ends of the keel members are further from the base than the ends adjacent the hinge, with the keel members 24, 26 projecting laterally away from the base 22 in generally opposing directions towards port and starboard respectively.

[0039] Each of the keel members 24, 26 is able to move from the first position to a compressed position, in which the free ends of the keel members 24, 26 are moved towards the base in response to a compression loading. The compressed position of the keel members is shown in Figure 5 and in ghost at 24A in Figure 4. The arrows in Figure 5 indicate a compression loading which may result from the vehicle being grounded and the keel members coming into contact with the ground or some other obstacle underneath the hull of the vehicle. This is most likely to occur either when the vehicle is travelling on land or when making the transition between land and water use. The ability of the keel members 24, 26 to be elastically deformed in this way enables them to absorb impact forces and so minimise damage. When fully compressed, the stops 46 on the keel members 24, 26 contact their respective stop members 48 ensuring that the keel members are able to return to the unloaded first position when the compression force is removed. Keel members 24, 26 will also

be pushed up as shown in Figure 5 when the vehicle is planing on water, due to the overall water pressure on the hull.

[0040] Figure 6 illustrates the keel in use in water when subjected to hydro-dynamic loading. When the vehicle turns on water, water pressure, indicated by the arrows in Figure 6, acts on the second surface 44 of one of the keel members 24, 26 (in this case the left hand keel member 24 as viewed) and pushes the free end of the keel member away from the base 22 until the keel member 24 reaches a fully extended position 24B, in which it projects substantially at right angles to the base. It will be understood that if the vehicle turns in the opposite direction, a lateral hydro-dynamic force acting in the opposite direction would act on the second surface 44 of the other keel member 26 in a similar fashion, to deflect the other keel member towards a fully extended position as indicated in ghost at 26B in Figure 4. The keel members 24, 26 will react in the same way whenever subjected to lateral hydro-dynamic loading whether this is as a result of the vehicle turning or due to other factors. Careful detail design is necessary to ensure that water can enter between the base 22 and the keel members 24, 26 to effect this change, even when the keel members are in the compressed position as shown in Figure 5.

[0041] The hinges 38 are arranged to increasingly resist movement of the keel members from the unloaded first position to the fully extended position 24B, 26B such that the hydro-dynamic forces are transferred from the keel members 24, 26 to the base 22 and hence to the hull 12 of the vehicle. Furthermore, stop means 46, 48 are provided to prevent, or at least to resist, movement of the keel members 24, 26 beyond their fully extended positions. This is illustrated in Figure 4, in which the right hand, as viewed, keel member 26 is shown in the fully extended position at 26B. In this position, the first surface 42 of the fully extended keel member 26B abuts the first surface 42 of the other keel member 24 deflecting the other keel portion upwardly to the position indicated in ghost at 24A. When the other keel portion 24 reaches the position 24A, the stop member 46 on the other keel portion 24 contacts stop member 48 on the base 22 to prevent further upward movement of the other keel portion 24 and so also preventing the keel portion 26 from being deflected beyond the fully extended position 26B.

[0042] It can be seen that the arrangement described above provides a keel in which the keel members 24, 26 are arranged to adopt a first position in which they lie close to the base when not subjected to loading. However, when subjected to lateral hydro-dynamic loading, the keel members 24 are adapted to automatically project further from the base 22, and hence the hull 12, and to transmit the lateral loading to the hull in the manner of a conventional keel. This arrangement is particularly advantageous when used on an amphibious vehicle. When the vehicle is used on land or when making the transition between land use and water use, the keel members 24, 26 will normally be in an unloaded condition in which they lie close to the base and hence the hull. In this position the keel members are less likely to be damaged through contact with the ground or other obstacles. Furthermore, the ground clearance of the vehicle is increased and the aero-dynamic drag caused by the keel may be reduced when compared to a conventional fixed keel. However, when the vehicle is used on water and the keel is subjected to a lateral hydro-dynamic loading, one of the keel members will automatically be deployed to aid handling and manoeuverability.

[0043] Whilst it is desired that the keel members 24, 26 lie as close as possible to the base 20 when in the unloaded condition, it is necessary to ensure that the lateral hydro-dynamic forces act on the upper surface 44 of a respective one of the keel members 24, 26 in order to deflect the keel member away from the hull. For this reason, it is preferred that the keel members 24, 26 are angled slightly away from the base 22 when in the unloaded position. Stop members 46 and 48 co-operate to ensure a gap between keel members 24 and 26 and base 22 when the vehicle is operative on water.

[0044] In the embodiment described above in relation to Figures 3 and 4, each keel member 24, 26 is separately connected to the base 22 by its own hinge 38. However, as shown in Figures 5 and 6, the keel members 24, 26 may be attached to the base 22 by means of a common hinge portion 38'. In the embodiment of Figures 5 and 6, this common hinge portion is solid, however, in a further alternative arrangement the common hinge portion 38" may be relieved with a central longitudinal cavity 25 as shown in Figure 7. Apart from saving material, this cavity

25 serves to enhance the hinging of keel members 24, 26 compared to the embodiment of Figures 5 and 6; and also enhances the shock absorbing capacity of the keel should it be grounded in its central region.

[0045] It may be found that when arms 24 and 26 are pushed up against the hull when planing, as shown in figure 5, they are reluctant to fall to positions 24B and 26B on corners. In this case, a further development of the keel as shown in Figure 7 may be used. If central cavity 25 is enlarged, and the forward and rearward ends of the keel are sealed so that water cannot enter into said cavity, the keel may be adapted so that hydrodynamic pressure acting upwards on the keel directly below cavity 25 will crush the centre of the keel, encouraging arms 24 and 26 to droop simultaneously (see positions 24B in figure 6 and 26B in figure 4). This may increase agility on water, in that the keel is instantly ready to aid handling as soon as the vehicle turns. On land, however, ground clearance and damage tolerance are maintained.

[0046] Figure 8 shows a further embodiment of the invention, in which the two keel members 124, 126 are separated and fitted to port and starboard sides of the hull respectively. Each keel member 124, 126 is formed integrally with a base member 122, 122' by means of extrusion from a resilient material such as rubber or a synthetic rubber or the like. The keel members 124, 126 being connected with their respective base members by a hinge portion 138.

[0047] The keel members 124, 126 in this embodiment are arranged to operate in the same manner as described with reference to the keel members 24, 26 of the previous embodiments for movement between the first position 124, 126 and the second, fully extended position 124B, 126B. A surface 150 on each keel member acts as a stop member for contact with the hull to prevent the keel member from moving beyond the fully extended position when subjected to a lateral hydro-dynamic loading.

[0048] Whereas the invention has been described in relation to what is presently considered to be the most practical and preferred embodiments, it is to be understood that the invention is not limited to the disclosed arrangements but rather is intended to cover various modifications and equivalent constructions included

within the spirit and scope of the invention as claimed. For example, whilst the invention has been described above principally in relation to an amphibious vehicle, it will be understood that the invention can be applied to any form of water craft, for example a boat, surfboard, sailboard or the like. Furthermore, whilst in the preferred embodiment, only one keel is shown on the hull of the vehicle, more than one keel can be used in a watercraft in accordance with the invention. For example two keels in accordance with the invention can be fixed along the hull, one on either side of the longitudinal centre line of the hull.